

NuWro neutrino generator

- ❑ Wroclaw neutrino generator, with much involvement by Jan Sobczyk on 10th floor!
- ❑ It could be built fully into LArSoft
- ❑ But for now we'll run nuwro and read it up into LArSoft, ala NUANCE and the GENIENdk way of doing things.
- ❑ Can compare with GENIE and NUANCE for uBooNE.

2 steps

- ❑ Run NuWro Standalone:
- ❑ Use the offline code repository's NuWro package README and setup scripts that describes how to use the combo ROOT/Pythia at /uboone/app/users/uboone/. Run the binary nuwro in the repository package.
- ❑ This produces an output.root file.
- ❑ That then is sucked in by the new LArSoft parser package in EventGenerator called NuWroGen.

Inputs for this run

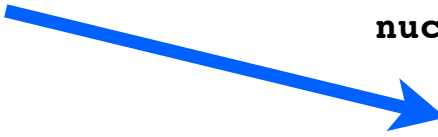
- ❑ @beam/uboone_numu_flux.txt
- ❑ @target/Ar.txt # at (1.25,0,1.0) m -- center, upstream in detector
- ❑ qel_vector_ff_set = 2 // BBBA05, hep-ex/0602017 BBBA05 for $Q^2 < 18$ GeV
- ❑ qel_axial_ff_set = 1 // dipole,
- ❑ sf_method = 1 // use grid spectral function: (C12, O16, Ar40, Fe56)
- ❑ # The choice of Delta production FF:
- ❑ # The dipole delta FF with pion_axial_mass=0.94 and pion_C5A=1.19
- ❑ # is our (Graczyk&JS) preferred choice

- ❑ delta_FF_set = 1 // Dipole delta form factors
- ❑ pion_axial_mass = 0.94 // in GeV units
- ❑ pion_C5A = 1.19
- ❑ coh_mass_correction = 1 //Rein Sehgal correction to CC coherent single pion production
- ❑ nucleus_model = 1 //"anynucleus" i.e. realistic density profile
- ❑ nucleus_E_b = 34 // [MeV] binding energy
- ❑ nucleus_kf = 220 // [MeV] Fermi momentum, used in Fermi gas model and in Pauli blocking
- ❑ pauli_blocking = 1 // enable (1) or not (0) Pauli blocking

Total count

- exposure of 70 tons, $6e20$ protons
- Ran 10,000 events, each contributing a weight equal to

```
double N_ArAtoms(70.*1000*1000/40*6.022e23);  
// arXiv:pdf/0806.1449v2.pdf adjusted to uBooNE distance  
//per cm^2/POT  
double FluxNorm(5.19e-10 * (540./460.)*(540./460.));  
double nucleiPerAtom((double)NuWroTTree->par.nucleus_p);  
double NumEvtsRunThisJob(10000.);  
if (NuWroTTree->in[NuWroTTree->in.size()-1].pdg==2112)  
    nucleiPerAtom = NuWroTTree->par.nucleus_n;  
// I think the weight coming out of NuWro is the xsection  
for that process.  
// double wt = NuWroTTree->weight * N_ArAtoms *  
nucleiPerAtom * 6.e20 * FluxNorm / NumEvtsRunThisJob;  
nucleiPerAtom=40.;  
double wt = fxsecFluxWtd.at(NuWroTTree->dyn) * N_ArAtoms  
* nucleiPerAtom * 6.e20 * FluxNorm / NumEvtsRunThisJob;
```



In progress ...

- ❑ I learned from Jan 2 days ago how to correctly calculate expected # of events.
- ❑ Implementing this I broke my code, and work right up until 1pm CDT did not correct the problem.
- ❑ All subsequent numbers are wrong. I believe they'll go up by 1.5+.
- ❑ Jennette's numbers are old, as well.

NuWro Comparison, Old accounting

-- with no p KE requirement

signature	NuWro (Eric/Josh)	NUANCE (Sam/Josh)	GENIE (Jennette & others)
CCQE	59514	55251	
NC elastic	4379	18122	
CC res p2ppi+	20079	15154	
CC res n2ppi0	3915	5679	
CC res n2npi+	2686	5536	
NC res p2ppi0	1707	2699	
NC res p2npi+	483	1662	
NC res n2npi0	1491	3383	
NC res n2ppi-	426	2229	
CC DIS	4243	1198	
NC DIS	507	427	
NC COH		865	
CC COH		1336	
Total of Above	100197	113541	
Grand Total	100197	117281	

NuWro Comparison, New accounting

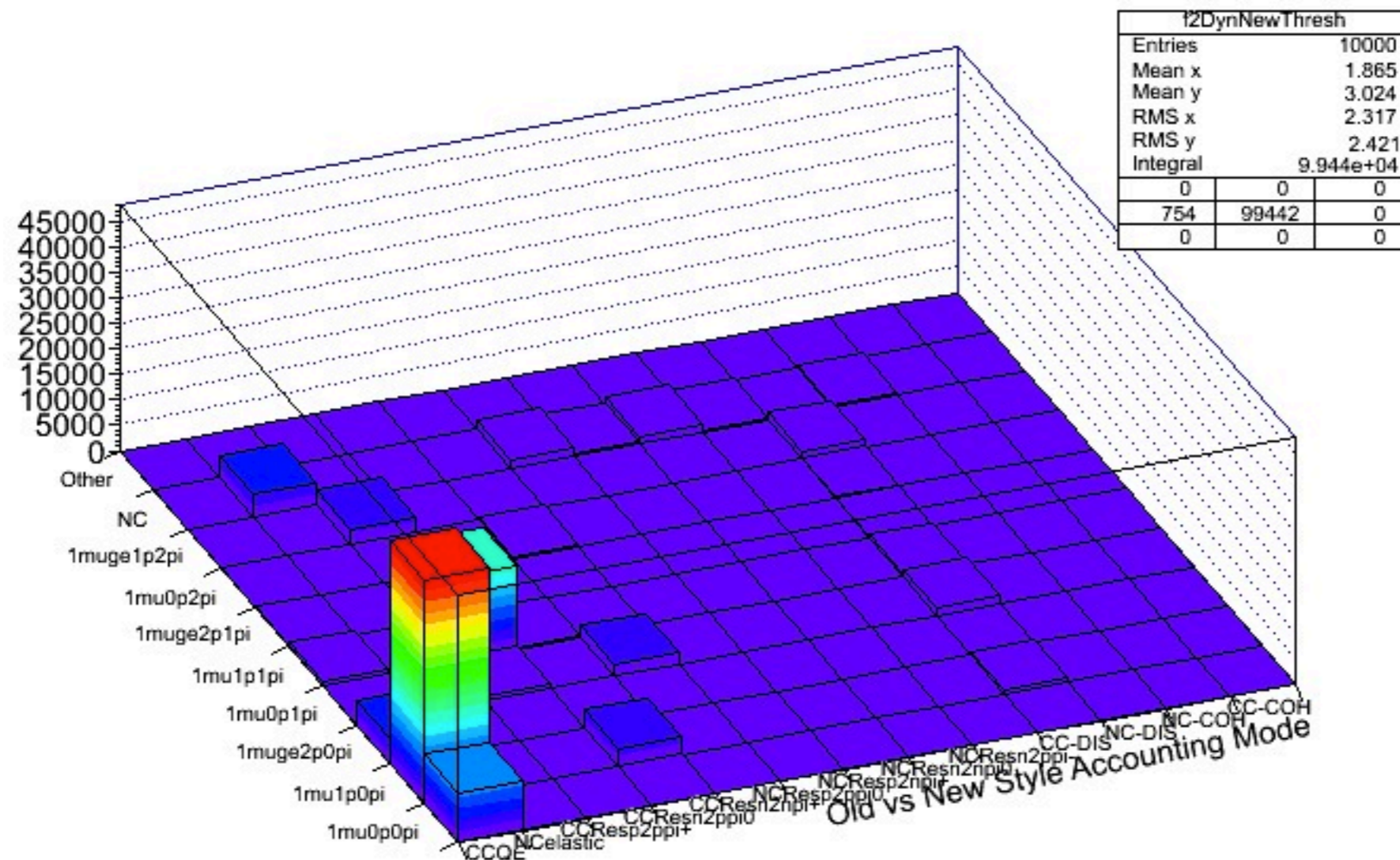
-- with no p KE requirement

signature	NuWro (Eric/Josh)	NUANCE (Sam/Josh)	GENIE (Jennette & others)
1mu0p0pi	4119	5	1502
1mu1p0pi	53257	15158	42192
1muge2p0pi	5418	44283	26330
1mu0p1pi	4207	915	4865
1mu1p1pi	18681	3993	15782
1muge2p1pi	286	14159	13079
1mu0pge2pi	663	320	547
1mu1pge2pi	4417	1556	1769
other	9145	36892	44025
Total	100197	117281	150090

NuWro protons w $KE > 50$ MeV

signature	NuWro (Eric/Josh)	NUANCE (Sam/Josh)	GENIE (Jennette & others)
1mu0p0pi	9874	12791	24724
1mu1p0pi	47962	21006	35914
1muge2p0pi	4958	25700	9400

Mechanism of production vs p/pi counting, requiring proton KE > 50 MeV



Other NuWro folklore

- ❑ $K^+ / - / 0$ s will come from DIS alone. No Cabibo-suppressed Lambdas in nubar, $p \rightarrow \mu^+, \text{Lambda}$ for example.
- ❑ I believe no de-excitation gammas are ever produced from excited nuclei. As is true of all our generators, I believe, but FLUKA. How can we get these? ArgoNeuT seems to see them. Can we put this question to the esteemed NuInt Generator panel?